Blueprint for a Missouri River Monitoring Program

Meeting #1: November 5-7, 1996

Omaha, Nebraska

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Author: Jim Milligan at 3ms-cmfo
Date: 9/6/96 11:56 AM
Priority: Normal
TO: Mark Laustrup at NBS-MSC
Subject: Resource Issues for MO River Monitoring Plan Region 3
---------- Message Contents ----------

The following represents the latest and greatest top five Missouri River operations related resource Monitoring Plan priority issue questions for Region 3.

1. How do river flows/reservoir operations affect surface area and depth of off-channel open water (sloughs, chutes, backwaters) and wetland (palustrine emergent, forested, shrub/scrub habitats? Alternatively, what flows by reach cumulatively optimize wetted area of off-channel habitat?

2. How do river flows/reservoir operations affect channel morphology (area and elevations of sandbars, and depth and velocity of water in the channel cross-section). Discharge/area relationships for sandbars and important depth/velocity combinations should be known if we hope to manage flows optimally. For example, knowing what flow cumulatively maximizes the volume of water 0-7 feet deep and < 2 fps velocity would help to establish annual recommendations for summer flows.

3. How do variations in river flow magnitude and timing affect native fish recruitment and benthic invertebrate production?

4. What are bed elevation trends (aggradation/degradation) by river reach and how will habitats (types and acres) be affected?

5. What river training structure/bank stabilization designs or features best diversify aquatic habitat and increase shallow (0-5 feet deep), low velocity water (< 1 fps and <2 fps) during normal summer navigation flows?

50 YEARS 1946-1996
ARGONNE NATIONAL LABORATORY
ENVIRONMENTAL ASSESSMENT DIVISION
9700 SOUTH CASS AVENUE, BUILDING 900, ARGONNE, ILLINOIS 60439
TELEPHONE 630/252-3107
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September 11, 1996

Dr. Mark Lastrup
National Biological Service
Midwest Science Center
4200 New Haven Road
Columbia, MO 65201-9634

Dear Dr. Lastrup:

Thank you for the opportunity to comment on the proposed strategy for developing the "Blueprint for a Missouri River Monitoring Program." Our comments are based on our participation in the Missouri River Natural Resource Committee meeting at Topeka last month and our review of the proposal that was discussed at that meeting.

Multiple Use
The proposal describes a wide range of uses for the river and recognizes the need for more integration of activities throughout the basin. Those uses, as well as nearly all the values that people hold for the river, relate to flow conditions. Because the structures on the river enable management of flow, there is some opportunity to optimize flow conditions for a variety of uses and values. We recommend that the full range of river uses be considered while developing the biological monitoring plan.

Involve all Stakeholders
While the proposal focuses on the flow conditions that are important for fish and wildlife, involving all the stakeholders in developing a biological monitoring plan is a good idea. There may be opportunities to coordinate efforts, combine resources, share data, and build stronger relationships that would benefit all users. With the exception of providing a facilitator, one key organization not identified to participate in the plan development meetings is the Corps of Engineers. We recommend that the Corps be invited to participate in the technical meetings to develop the monitoring plan.

Priorities
As development of the monitoring plan proceeds, we recommend assigning priorities to the various tasks identified for accomplishment. There will be limits on how much can be done and it is critical that the most important work is included. Among other measures used for assigning priority should be the extent that a task addresses more than one value of the river.

Alternatives
We recommend that an objective of the monitoring plan should be to form a basis for comparing biological parameters along with economic, legal, and other parameters when developing alternative flow optimization strategies. Information resulting from these comparative analyses will then provide for biological considerations to be included in the decision for river management.

Remote Sensing
Remote sensing is useful for monitoring the impacts of different flows on the river environs. It can also be used to extrapolate the results of intensive sampling at individual sites to similar sites in the river corridor. It can be particularly useful and cost effective for simultaneously supporting multiple tasks identified in the monitoring plan. We recommend that remote sensing be considered as one of the tools used to implement the monitoring plan.

New Title
Although the title or product of this entire effort is characterized as a monitoring plan, we believe that this could be misinterpreted. We believe that rather than a monitoring plan, it is a plan for gathering data which will allow a decisionmaker access to information specifically designed to assure the sustainability of the biological and natural resources of the Missouri River. In that regard, it is more of a structured or systematic inventory that is focused on obtaining data that will contribute to that decisionmaking purpose. By comparison, we view monitoring as measuring results or performance against a preconceived model or set of expectations. We suggest that a new title, such as biological systems inventory plan be considered as an alternative to monitoring plan.

At Argonne, we have considerable experience and capability in internal and external (public involvement) scoping, analysis, integration, and application of natural resource information. We would like to participate in the Blueprint strategy meeting at Omaha on November 5, 6, & 7 and the subsequent technical meetings to develop the plan and hope that we will be welcome to do so. We look forward to working with you.

Sincerely,

Anthony J. Dvorak, Ph.D.
Director
Environmental Assessment Division

AJD/er

cc: J. Krummel
K. LaGory
B. Moore

Author: "Dale W Blevins; Supervisory Hydrologist; Independence; MO "<dblevins@usgs.gov> a
t NBS-Internet-Gateway
Date: 9/11/96 1:59 PM
Priority: Normal
TO: Mark Laustrup at NBS-MSC
TO: dblevins@usgs.gov at NBS-Internet-Gateway
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CC: southard@usgs.gov at NBS-Internet-Gateway
Subject: 5 questions for MRNRC MO River Ecosystem monitoring plan
---------- Message Contents ----------

As requested, 5 questions regarding the effects of river management on the Missouri River ecosystem from the USGS-WRD are listed below. We feel these questions address critical understandings needed to accomplish ecological goals expressed by many members of the MRNRC.

6
1. What velocity and flow regimes in the main channel, dike fields, and side channels of the Missouri River are preferred by various aquatic species?

Instream velocity patterns are controlled by water levels and discharges in the river. Consequently, system operation has a direct effect on the location and desirability of areas of preferred habitat for aquatic species. Acoustic Doppler Profilers represent a new technology needed to measure flow velocity on a scale needed for habitat assessment. Characterization of flow velocities in a wide variety of river reaches and instream locations (such as tributary inflows, scour holes attached to the river, dike fields, and main channel edges) need to be compared with the density of fish and other aquatic species within those areas.

7
2. What causes and what are the ecological effects of low dissolved oxygen (as low as 2.5 mg/L) during rises of the Missouri River.

A very small amount of continuous dissolved-oxygen data (approximately 6 months) shows that dissolved oxygen can decrease to values as low as 2.5 mg/L during some rises of the lower Missouri River. The effect of river management on these dissolved oxygen sags is unknown because the cause of these decreases is not known. Also, the long duration of rises and the associated low dissolved oxgen on the Missouri River may have significant ecological effects, limiting some species and providing advantages for others.

8
3. What effect do system operations have on the quantity and quality of detritus in the Missouri River?

Ecosystems of large rivers are typically based on microbial

consumption of detritus rather than primary production. Therefore, the quantity and quality (digestability) of detritus and organic material in the river is the foundation of the entire ecosystem. Therefore, the effects of river management on the quantity and quality of particulate and dissolved organic matter as well as the microbial communities consuming the detritus need to be characterized in relation to flow regimes and location in the channel.

9

4. What are the relationships between nutrients, turbidity and primary production and between turbidity and the abundance of sight-feeding species. How would turbidity and nutrient availability change under different river management scenarios?

Although ecosystems of most large rivers are usually based on microbial consumption of detritus, large anthropomorphic inputs of nutrients can allow significant growth of algae when light is not severely limited by particulates in the water. River management can have a significant impact on water clarity and nutrient availability. Small increases or decreases in the role of primary production can cause significant changes in communities. Therefore, the role of algae in the Missouri River and its response to system operation need to be detemined. Also, species composition is profoundly effected by the availability of light for sight-feeding species. The effects of light on the river ecosystem may vary even within the channel (main channel, dike fields, side channels, etc.)

10

5. What effects do different river management scenarios have on the movement and placement of bottom sediments in various habitats within the Missouri River?

Controlled releases and channel structures have caused major changes in the movement and placement of bottom sediments in the Missouri River. The movement and changes in placement of bottom sediments have direct affects on the desirability of aquatic habitats. Much historical suspended-sediment data has been collected on the Missouri River, but few compilations or interpretations have been published. Also, rating curves at gaging stations can reveal long-term trends in aggradation and degradation at the gaging stations. Individual discharge measurements at these stations can reveal seasonal trends aggradation and degradation caused by managed flow regimes or temperature (water density) differences. Therefore, relations between flow regimes (river-management scenarios) and the movement and placement of bottom sediment need to be determined.

interoffice
MEMORANDUM

to: Mark Laustrup
from: Greg Power
subject: Missouri River Informational (Data) Needs
date: September 11, 1996

We attempted to fine-tune a number of Missouri River System - related issues and assimilate them into five questions (below). Compiling and grouping these needs basin-wide may be a real challenge - let me know how it goes. Thanks.

11

1 - What effect(s) does the timing (i.e hourly, daily, seasonally) and magnitude of releases from Garrison Dam (a.k.a. all dams) have on - a) habitat (e.g. backwater, side channels, sandbars, etc), b) fish reproduction, distribution and movements, and c) least tern, piping plover, and Canada geese nesting and rearing of young.

12 2 - Seasonally determine the magnitude of fish transfer/loss/mortality from Garrison Dam (a.k.a. all dams).

13 3 - Characterize habitat changes caused by river bed degradation and reservoir headwater aggradation and relate findings to long-term impacts to aquatic biota.

14 4 - Determine the importance of Missouri River tributaries for fish reproduction and general fish distribution.

15 5 - Develop reliable methodology for accurately determining the annual coldwater forage biomass in Lake Sakakawea (a.k.a. all reservoirs).

To: Mark Laustrup, USDI-NBS, Midwest Science Center, 4200 New Haven Road, Columbia, Missouri 65201

From: Gene Zuerlein, NGPC, 2200 North 33rd St., Lincoln, Nebraska 68503

Subject: MRNRC - Missouri River Monitoring Plan

Date: 12 September 1996

\\\

Nebraska Response

Objective - identify and prioritize issues related to the impact of the system on the natural resources of the Missouri River. Phrase issues as questions.

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1.16 How much and to what extent has modification of the physical **form** of the Missouri River impacted the normal ecological **functioning** of this river?

2.17 Present system modification and operation has reduced water management **flexibility** for the Corps of Engineers. This in turn may be having an impact on fish carrying capacity (biomass of fish) in riverine sections (especially channelized reaches) because flow regimes are not synchronized with historic species reproductive cycles/time frames. **What can be done to maximize the carrying capacity of fishery resources in the Missouri River?**

3.18 A significant percentage of the water in the lower Missouri River (below Gavins Point Dam to the mouth) comes from **tributary inflows. How can system releases be managed more efficiently for fish and wildlife purposes without seriously impacting other project users detrimentally?**

4.19 System operation of the Missouri River has not changed to reflect the fact that **few barges move on the river** and the total weight of commodities hauled are only a fraction of what the system was designed for. Essently, water is being wasted at the expense of other uses that could be more profitable to each basin state and society in general. **How could system water be more efficiently utilized to enhance fish and wildlife resources?**

20 5. **Flood control activities/operations** downstream of Ft. Randall and Gavins Point dams since 1952 frequently involves side channels, backwaters, chutes, and the main channel being dewatered (flows shut off and dramatically reduced) to the detriment of fish, macroinveterbrates, and wildlife resources. **How can populations of fish and wildlife resources in the unchannelized reaches below these two dams be protected rather than decimated during flood control activities?**

21 6. A high percentage of all **shallow water habitat types (side channels, braided channels, riparian lands, chutes, sloughs, islands, sandbars, backwater areas, and natural floodplains) have been impacted/lost or their function impaired** in/along the channelized Missouri River due to system operation/development. **What can be done to improve/increase these types of habitats in order that species life requirements, including reproductive cycles of aquatic resources, can be better met?**

22 7. Present system modification and operation has **narrowed the Missouri River and increased the velocity** in the channelized section which negatively impacts user groups who would increase their recreational activities if it were more user friendly. **How can the system be managed to support new economic growth in the recreational industry?**

23 8. Operation of the present system has encouraged increased **encroachment onto the floodplain** and repeatedly rescued those who do so with public funds from the U.S. Treasury. As a consequence, Missouri River natural resources and the habitats needed to support them for future generations are diminishing at an accelerating rate. **What can be done to manage floodplain encroachment in a manner both affordable to the taxpayer and compatible to the long term needs of fish, wildlife, and recreation?**

//

cf: Gabelhouse
Mestl

STATE OF IOWA
TERRY E. BRANSTAD, GOVERNOR
DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

NW REGIONAL OFFICE
Fish Management Section
611 252nd Avenue
Spirit Lake, IA 51360

September 13, 1996

Mark Laustrup
Midwest Science Center
4200 New Haven Road
Columbia, Missouri 65201

Dear Mark:

The task became more formidable with each passing thought! I hope the collaborative efforts of the many outweigh the pitiful attempts of the few (me).

- 24 What tools are needed for predicting the response of fisheries (sport, commercial, nuisance and endangered) to hydrologic manipulation?

- 25 What measures are good descriptors of the critical features of flow regimes and habitat diversity? What is the relationship among flow regime, habitat diversity and productivity? What habitat features are the most important and how much habitat of each kind is required?

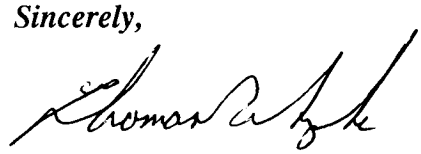
- 26 What are the abiotic end points that can be realistically targeted in rehabilitation programs? What doe the mosaic of habitats that is critical to river form and function look like?

- 27 What is the impact of current system operation on the fish, aquatic organisms, riparian habitat, floodplain and floodplain dependent organisms which evolved under a hydrograph where there was a summer low flow?

- What has been the effect of present day restoration efforts? What are the most effective/holistic techniques? What trends are - or should be - monitored to assess the impact of restoration efforts?

When the questions are difficult to articulate I can't help but wonder what the "synthesis of the task" into a reasonable action program will require.

Sincerely,



Thomas W. Gengerke
Regional Fisheries Supervisor

TWG/wjs

September 13, 1996

To: Mark Laustrup, National Biological Service

From: Warren Hill, National Park Service

Subject: Issues related to the impact of operation on the natural resources of the Missouri River

We suggest that the following research questions be addressed in a monitoring plan developed by the Missouri River Natural Resources Committee:

1) What is the status of water quality, water chemistry, and aquatic resources along the Missouri National Recreational River between Fort Randall Dam, South Dakota and Ponca State Park, Nebraska? Document the information that currently exists on these topics. Measure changes in water quality, water chemistry, and aquatic resources at various locations along the Missouri River periodically into the future. Relate the measurements on water quality and water chemistry to such uses as contact recreation, drinking water supply, and cold water fishery.

2) What is the present status of sedimentation, delta building, and habitat alteration along the Missouri River at the mouth of the Niobrara River? How far upriver and how far downriver of the Niobrara confluence is sedimentation, delta building, and habitat alteration occurring? What is the rate of sediment deposition at the mouth of the Niobrara River, as well as upstream and downstream? Provide future forecasts of sedimentation, delta building, and habitat alteration along the Missouri River as a result of Ft. Randall Dam releases.

3) What are the effects of dam releases on the cottonwood forest habitat along the Missouri River? Document whether and to what extent Missouri River farmland is being transformed into marshland.

Warren H. Hill

STATE OF KANSAS

DEPARTMENT OF WILDLIFE & PARKS

Office of the Secretary
900 SW Jackson, Suite 502
Topeka, KS 66612
913/296-2281 FAX 913/296-6953

MEMORANDUM

TO: Mark Laustrup
National Biological Service
Midwest Science Center

FROM: Steve Adams
Natural Resources Coordinator

DATE: September 16, 1996

SUBJECT: Missouri River Monitoring, Priority Issues

Following are general issues that we have identified as priorities to include as a starting point for development of a monitoring effort for the Missouri River. Please let us know if you need additional information.

32 • What management techniques can be used in the channelized section of the river to better approximate the natural system and what changes in the biotic community occur when these techniques are used.

33 • What influence does water release patterns have on habitat availability in the lower river.

34 • Status of fisheries, riparian wildlife communities and migratory bird species affected by management of the system.

35 • What is the influence of non-native species (i.e. Asian carp sp.) on the native species of the system.

36 • Status and trends in quality and area of habitats. Including; riverine, riparian & floodplain (woodlands, wet meadows, etc.), emergent and riverine wetlands, sandbars, shallow water, side channels and backwaters.

xc Richard Sanders, KDWP
Roger Wolfe, KDWP
Tom Mosher, KDWP
Greg Power, ND Game & Fish
Kent Keenlyne, FWS

From William.GLENN.Covington@MRK01.usace.army.mil Tue Sep 17 18:22 CDT 1996
From: William.GLENN.Covington@MRK01.usace.army.mil
X400-Received: by mta mtaeml01 in /c=us/admd=attmail/prmd=gov+usace/;
converted (IA5-Text); Relayed; 17 Sep 1996 22:16:35 Z
X400-Received: by /c=us/admd=attmail/prmd=gov+usace/; converted (IA5-Text);
Relayed; 17 Sep 1996 22:16:35 Z
X400-MTS-Identifier: [/c=us/admd=attmail/prmd=gov+usace/; 323F2293.8F72.2038.00
Content-Identifier: 008B0323F2343001
Content-Return: Allowed
X400-Content-Type: P2-1988 (22)
Conversion: Allowed
Original-Encoded-Information-Types: IA5-Text
Disclose-Recipients: Prohibited
Alternate-Recipient: Allowed
X400-Originator: William.GLENN.Covington@MRK01.usace.army.mil
X400-Recipients: non-disclosure;
Date: 17 Sep 1996 22:16:35 Z
To: mlaustrup@msc.nbs.gov (Return requested)
Subject: Missouri River Issues
MIME-Version: 1.0

The following is a prioritized list of Missouri River issues from the Kansas City District, Corps of Engineers. Sorry for being late.

37

1. What are the critical limiting factors for the pallid sturgeon in the lower Missouri River?

38

2. Does a riparian corridor, along the lower Missouri River, provide any significant protection for levees during flood events and reduce levee breaching?

39

3. Does a riparian corridor, along the lower Missouri River, cause a significant rise in flood stages?

40

4. What is the nutrient load of the lower Missouri River and how does it impact aquatic species?

41

5. Are there areas of unique aquatic habitat in the lower Missouri River?

Let me know if you have any questions and good luck.

DEPARTMENT OF GAME, FISH AND PARKS
Reservoir Fisheries Center
Foss Building
523 East Capitol
Pierre, South Dakota 57501-3182

September 17, 1996

Mark Laustrup
Midwest Science Center
4200 New Haven Road
Columbia, Missouri 65201

Dear Mark:

Attached is a list of issue questions from South Dakota. We are still considering this exercise and will undoubtedly think of more questions as we work through the plan.

I like the idea of developing a group vision and all heading in the same direction. These questions will also help determine what we need to know to be successful at managing biological diversity of the Missouri River. Keep us informed.

Sincerely,

Dennis Unkenholz
Division Staff Specialist

cc: George Vandel, Game, Fish and Parks
Eileen Dowd-Stukel, Game, Fish and Parks
Bob Hanten, Game, Fish and Parks
Bill Stewart, Dept. of Environment and Natural Resources

Phone: 605/773-5535 FAX: 605/223-2337

SOUTH DAKOTA ISSUE QUESTIONS

42. 1. What is the status of fish populations (both native and non-native) in reservoirs and free flowing river reaches between reservoirs?

43. 2. What are trends in water quality parameters such as dissolved oxygen, temperature, total dissolved solids and some measure of trophic state?

44. 3. What are the erosion/sedimentation parameters related to tributary inflows, reservoir shorelines and storage depletion?

45. 4. What is the status of riparian and aquatic habitat in and along the free flowing river reaches?

46. 5. What are the benefits associated with unbalanced management of reservoir storage?

MISSOURI DEPARTMENT OF CONSERVATION

Headquarters
2901 West Truman Boulevard, P.O. Box 180, Jefferson City, Missouri 65102-0180
Telephone: 573/751-4115 ◆ Missouri Relay Center: 1-800-735-2966 (TDD)

JERRY J. PRESLEY, Director

September 18, 1996

Mark Laustrup
Midwest Science Center
National Biological Service
4200 New Haven Road
Columbia, MO 65201

Dear Mark:

Thank you for providing an opportunity to comment on what we think are important issues related to the effects of Missouri River system operation on river biota. The five issues we identified are as follows:

47, 1. What are the cumulative effects from rock control structure construction on system biota?

48 2. What effect does the current system of levees, constructed adjacent to the river, have on the river's productivity and subsequent biotic production?

49. 3. What effect does the release of high water from Gavins Point Dam, during summer and fall months, have on year class strength (measured by survival and growth) of fishes produced along the lower Missouri River?

50. 4. How important is shallow water habitat (e.g., sand deposited by structures) to year class strength of lower Missouri River fish? Is this habitat replacing natural sandbar habitat?

51, 5. Has a delayed spring hydrograph, resulting from late upper system reservoir releases, altered the spawning sequence of large river fishes (e.g., buffalo spp.) between Gavins Point Dam and the mouth of the Kansas River (tributaries below the Kansas River influence the lower river's hydrograph)?

Again, thank you for the opportunity to comment.

Sincerely,

Gordon

GORDON B. FARABEE
POLICY ANALYST

GBF:fef

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
1500 East Capitol Avenue
Bismarck, North Dakota 58501

SEP 25 1996

MEMORANDUM

To: Director, Midwest Science Center, National Biological Service
Columbia, Missouri (Attn: Mark Laustrup)

From: Acting Field Supervisor, North Dakota Field Office
Bismarck, North Dakota

Subject: Questions/Issues for Missouri River Monitoring Plan

During the August 6-8, 1996, annual meeting of the Missouri River Natural Resources Committee, you requested feedback from each agency on the most important issues/questions that should be addressed in a Missouri River monitoring plan. In addition to monitoring baseline fish and wildlife populations and habitat trends, I emphasize that a monitoring program on the Missouri River should measure the specific effect of operations or restoration actions on riverine and reservoir fish and wildlife resources. It should be designed to address the response of the ecosystem (habitat, biological communities, water quality, etc.) to any incremental changes in the flow regime and operation of the system, or to habitat restoration. This type of information is necessary to justify management recommendations. Under separate cover, I am sending you copies of excerpts from Fish and Wildlife Service correspondence to the Corps of Engineers and other background information regarding our concept of a Missouri River monitoring program.

I offer six questions/issues that primarily relate to the upper Missouri River basin above Sioux City, Iowa. Questions on the lower channelized river below Sioux City are being addressed by Jim Milligan of the Columbia Fishery Resource Office in Missouri (Region 3 - Fish and Wildlife Service).

52.

1. What is the relationship between discharge and availability of sandbar habitat (i.e., area and elevation) in river reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams? What is the optimal range and timing of discharge for the creation, enhancement, and maintenance of suitable sandbar habitat important to the conservation and recovery of the

least tern and piping plover? How much sandbar habitat is necessary to maintain recovery populations of terns and plovers?

53. 8. What is the relationship between discharge and the availability of shallow-water (i.e., side channels, chutes, oxbows, backwaters, sloughs) habitat in the riverine reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams in the spring and summer? What is the optimal range and timing of discharge to enhance or restore these habitats while maintaining flood control and other authorized purposes in each reach? How much and what depths of shallow-water habitat are needed to maintain healthy native fish populations?

54. 8. How do changes in main stem dam and reservoir operations affect the productivity of fish, wildlife, and invertebrate communities and their habitats (i.e., diversity, abundance, distribution)? What are the optimum flows, river stages, and reservoir elevations (or ranges of each) in the spring and the summer in each river reach or reservoir to optimize aquatic, riparian, and floodplain habitats and native fish and wildlife populations?

56. 4. What is the relationship of discharge, including daily peaking for hydropower, to bank erosion, river bed degradation, riverine and off-channel habitat availability (i.e., shallow-water habitats near sandbars, chutes, oxbows, backwaters, etc.), and accretion/delta formation in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams? What are the cumulative impacts of Federal and private bank stabilization projects in these riverine reaches on fish and wildlife habitat abundance and availability, population communities, and delta formation? What is the best way to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches?

56. 5. What are the key or limiting factors to native fish recruitment and benthic invertebrate production (temperature?, turbidity? more natural hydrograph?, shallow-water habitat?, etc.)? Special studies may be needed to determine the relationship between discharge and these factors. If a factor is determined to be limiting, what is the optimum range or timing of discharge, or structural modification, that is needed for improvement?

57. 6. What is the probability that native Missouri River fishes, such as the paddlefish or endangered pallid sturgeon, would benefit from a fish passage structure at the main stem dams? For example, a structure could connect priority pallid sturgeon recovery areas in river reaches below and above either Gavins Point or Fort Peck Dams? The answer may require a

special study to tag fish from the river reach below the dam, release them above the dam in the reservoir, and track any migration to upstream riverine reaches and document habitat use.

If you have any questions on these inputs, please call me (701-250-4481) or Roger Collins (701-250-4492).

Roger L. Collins

cc: ARD-MT/WY, Denver (60120)
ARD-CO/KS/NE/UT, Denver (60140)
Field Supervisors, ES
Columbia, Missouri
Helena, Montana
Pierre, South Dakota
Grand Island, Nebraska
Manhattan, Kansas
Sub-Office Coordinator, ES, Billings
Missouri River Coordinator, FFA, Pierre
Project Leader, Missouri River FWAO, Bismarck
Project Leader, Great Plains FWAO, Pierre
Project Leader, Columbia Fishery Resource Office

FAX COVER SHEET

U. S. DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

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BILLINGS MT 59107-0137
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PHONE: (406) 247-7295

No. of Pages 2 (Incl. Cover)

TO		FROM	
NAME	MARK Limstrup	NAME	Tom Parks
ATTN:		CODE	
CODE		PHONE NO.	(406) 247-7314
PHONE NO.		DATE SENT	10-17-96
FAX NO			

COMMENT(S): MARK - These Questions would read differently if the request Concerned all Resources in Missouri River. Power Production and irrigation supply runs a very close 2nd to the Natural Resources. Will Plan on discussing in Omaha.

THANKS, Tom

P.S. Sorry about the lateness of reply

MRNRC REQUEST

Each participant (agency) should identify and prioritize issues related to the impact of the operation of the system on the Natural Resources of the Missouri River.

58. 1.) How can operations (water and power) be ~~adjusted~~ managed to contribute to the value of habitat for large river dwelling aquatic resources generally considered as species in moderate to significant rates of decline.

59. 2.) How can the impacts of habitat segmentation (dams) and hydrology alteration be distinguished from land use practices, point non-point pollution (Ag and M&I), fishing and overharvest, inter/intra specific competition, non-federal flow depletions.

60. 3.) How can operations (water and power) be managed to contribute to the value of habitat for water associated resources such as cottonwoods, piping plover, least tern, various neotropical migratory species of birds, Ampibians, reptiles.

61. 4.) How should cold water (non-native salmonid) habitats be prioritized with respect to contributing to biological diversity? State and local economics?

62. 5.) How should operations identified to draw out positive biological responses be balanced to also meet such diverse non-biological demands as recreational reservoir levels (non-fishery), shoreline development (river and reservoir), river floating, concession operations.

M

1. I believe that the single largest effect the dams and their operation have had is to change the fluvial geomorphology of the river. Sediment has been taken out of the system. Flow regimes have been severely altered. The channel has been narrowed and straightened. Side channels have been eliminated. We have bed degradation in some places and aggradation in other. We need to monitor the physical attributes of the channel (width, depth, habitat types etc.) and the physical processes that shape them.

2. I believe that we should have a two tiered approach to monitoring. One tier would be of the traditional type of annual monitoring. But I would do this at a much higher level than the Mississippi. By that I mean I would monitor very basic things rather than a whole bunch of detailed things. I believe that this type of data would be more likely to be used and would be much easier to make sense of. I would monitor temperature, flow, sediment, physical habitat, perhaps an indicator of productivity such as total organic carbon, a few suspect metals, benthic fishes (see number 3), and a select few amphibians, birds and mammals. I might be convinced to do a little bug work, but not a tremendous amount.

3. I like the idea of using the benthic fish study as a basis for a continuing fish monitoring effort. Some of the best people in the basin have put a lot of thought into that study. My only question is whether we feel that the benthic fish community is adequate to describe the entire fish community. I worry that some of us fish people may say no just because fish is what we like to do. We need to be objective in our analysis of this question.

4. The second tier of this monitoring program should be more directed to answer specfic questions about the effect of specific operations on the physical habitat and its inhabitants. We could chose a reach of river, say below Ft. Peck, to conduct a multiple year study of the effect of a spring freshet on the habitat, amphibians, fish, birds and mammals. We could conduct a multiple year experiment to determine how operations affect bed aggradation below Gavins. We could look at what flows actually cause flooding and what types of lands are flooded at 36,000 cfs.

5. I have assumed all along that this monitoring program was directed at the river and not at the reservoirs. Is that assumption correct? If not then we need to have a good discussion about whether it should include the reservoirs. That would complicate this monitoring plan quite a bit.

Author: "Dale W Blevins; Supervisory Hydrologist; Independence; MO "<dblevins@usgs.gov> at NBS-Internet-Gateway
Date: 11/25/96 3:43 PM
Priority: Normal
TO: Mark Laustrup at NBS-MSC
CC: dblevins@usgs.gov at NBS-Internet-Gateway
Subject: new issue for Missouri River monitoring effort
---------- Message Contents ----------

I would like to add another issue (question) for the group meetings in January:

What effect do various river-management scenarios have on the hydroperiods of riparian wetlands and ground-water levels in the Missouri River floodplain.

This is a question that the Omaha COE has asked me to propose to the MRNRC monitoring group and is of interest to the USGS-WRD. The MO DNR also has a strong interest in this issue. I should have included it in the original 5 questions. I'm not sure which of the 3 groups (aquatic, terrestrial, or water quality) should address this issue, so assign it to whichever group you like.

Thanks.

missed deadline

A STARTING POINT

A total of 62 issues were submitted for inclusion. The agency responses were ordered by the date submitted and then sequential numbers were assigned to the issues. The issues fall in to five broad categories: habitat (20); biota (19); Hydraulics/hydrology (14); Water quality (5); and Policy (4). There is considerable overlap between an issue and the broad categories. I have included my interpretation by appending one or more of the following codes to the end of each issue which mentions more that one category: **BIO** = Biota; **HAB** = Habitat; **H/H** = Hydraulics/Hydrology; **WQ** = Water quality; **POL** = Policy. I attempted to assign an issue to a category based on its content. Figure 1 summarizes my perception of how the issues relate to the categories.

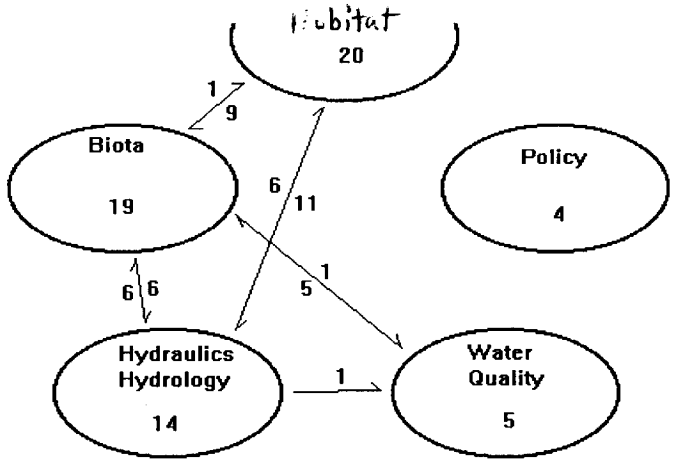

Figure 1. Five broad categories encompassing issues related to the operation of the Missouri River. Using the category 'Habitat' and an example, there were 20 issues related primarily to habitat. Of the twenty, 9 also mentioned 'Biota' and 11 also mentioned some component of hydraulics/hydrology.

Figure 1. serves to illustrate the close relation between habitat, biota, and hydraulics/hydrology. Argonne suggested that we somehow prioritize our efforts in order to make sure that we accomplish the important things first. I think the diagram with help to that end. Isn't this going to be fun! I am going to continue working on this the rest of the week, primarily to further break down the broad categories into like groups, i.e. biota = fish + invertebrates + terns/plovers + neotropical birds + ...See you next week...

Biota

3. How do variations in river flow magnitude and timing affect native fish recruitment and benthic invertebrate production? **H/H**

8. What effect do system operations have on the quantity and quality of detritus in the Missouri River?

12. Seasonally determine the magnitude of fish transfer/loss/mortality from Garrison Dam (a.k.a. all dams).

14. Determine the importance of Missouri River tributaries for fish reproduction and general fish distribution.

15. Develop reliable methodology for accurately determining the annual coldwater forage biomass in Lake Sakakawea (a.k.a. all reservoirs).

16. How much and to what extent has modification of the physical form of the Missouri River impacted the normal ecological functioning of this river? **Goal of Monitoring?**

17. Present system modification and operation has reduced water management flexibility for the Corps of Engineers. This in turn may be having an impact on fish carrying capacity (biomass of fish) in riverine sections (especially channelized reaches) because flow regimes are not synchronized with historic species reproductive cycles/time frames. What can be done to maximize the carrying capacity of fishery resources in the Missouri River? **Goal of Monitoring?**

18. A significant percentage of the water in the lower Missouri River (below Gavins Point Dam to the mouth) comes from tributary inflows. How can system releases be managed more efficiently for fish and wildlife purposes without seriously impacting other project users detrimentally? **Goal of Monitoring?**

24. What tools are needed for predicting the response of fisheries (sport, commercial, nuisance and endangered) to hydrologic manipulation? **H/H**

27. What is the impact of current system operation on the fish, aquatic organisms, riparian habitat, floodplain and floodplain dependent organisms which evolved under a hydrograph where there was a summer low flow? **H/H**

34. Status of fisheries, riparian wildlife communities and migratory bird species affected by management of the system.

35. What is the influence of non-native species (i.e. Asian carp sp.) On the native species of the system?

37. What are the critical limiting factors for the pallid sturgeon in the lower Missouri River?

42. What is the status of fish populations (both native and non-native) in reservoirs and free flowing river reaches between reservoirs?

48. What effect does the current system of levees, constructed adjacent to the river, have on the river's productivity and subsequent biotic production?

49. What effect does the release of high water from Gavins Point Dam, during summer and fall months, have on year class strength (measured by survival and growth) of fishes produced along the lower Missouri River? **H/H**

51. Has a delayed spring hydrograph, resulting from late upper system reservoir releases, altered the spawning sequence of large river fishes (e.g., buffalo spp.) Between Gavins Point Dam and the mouth of the Kansas River (tributaries below the Kansas River influence the lower river's hydrograph)? **H/H**

56. What are the key or limiting factors to native fish recruitment and benthic invertebrate production (temperature?, turbidity?, more natural hydrograph?, shallow-water habitat?, etc.)? Special studies may be needed to determine the relationship between discharge and these factors. If a factor is determined to be limiting, what is the optimum range or timing of discharge, or structural modification, that is needed for improvement? **H/H, WQ, HAB**

57. What is the probability that native Missouri River fishes, such as the paddlefish or endangered pallid sturgeon, would benefit from a fish passage structure at the main stem dams? For example, a structure could connect priority pallid sturgeon recovery areas in river reaches below and above either Gavins Point or Fort Peck Dams? The answer may require a special study to tag fish from the river reach below the dam, release them above the dam in the reservoir, and tract any migration to upstream riverine reaches and document habitat use.

Habitat

2. How do river flows/reservoir operations affect channel morphology (area and elevations of sandbars, and depth and velocity of water in the channel cross-section).? Discharge/area relationships for sandbars and important depth/velocity combinations should be known if we hope to manage flows optimally. For example, knowing what flow cumulatively maximizes the volume of water 0-7 feet deep and < 2 fps velocity would help establish annual recommendations for summer flows. **H/H**

5. What river training structure/bank stabilization designs or features best diversify aquatic habitat and increase shallow (0-5 feet deep), low velocity water (< 1fps and < 2 fps) during normal summer navigation flows? **H/H**

21. A high percentage of all shallow water habitat types (side channels, braided channels, riparian lands, chutes, sloughs, islands, sandbars, backwater areas, and natural floodplains) have been impacted/lost or their function impaired in/along the channelized Missouri River due to system operation/development. What can be done to improve/increase these types of habitats in order that species life requirements, including reproductive cycles of aquatic resources, can be better met?

25. What measures are good descriptors of the critical features of flow regimes and habitat diversity? What is the relationship among flow regime, habitat diversity and productivity? What habitat features are the most important and how much habitat of each kind is required? **H/H**

26. What are the abiotic end points that can be realistically targeted in rehabilitation programs? What does the mosaic of habitats that is critical to river form and function look like?

28. What has been the effect of present day restoration efforts? What are the most effective/holistic techniques? What trends are - or should be - monitored to assess the impact of restoration efforts?

31. What are the effects of dam releases on the cottonwood forest habitat along the Missouri River? Document whether and to what extent Missouri River farmland is being transformed into marshland. **H/H**

32. What management techniques can be used in the channelized section of the river to better approximate the natural system and what changes in the biotic community occur

when these techniques are used? **BIO**

33. What influence does water release patterns have on habitat availability in the lower river? **H/H**

36. Status and trends in quality and area of habitats. Including riverine, riparian & floodplain (woodlands, wet meadows, etc.), emergent and riverine wetlands, sandbars, shallow water, side channels and backwaters.

41. Are there areas of unique aquatic habitat in the lower Missouri River?

45. What is the status of riparian and aquatic habitat in and along the free flowing river reaches?

47. What are the cumulative effects from rock control structure construction on system biota? **H/H, BIO**

50. How important is shallow water habitat (e.g., sand deposited by structures) to year class strength of lower Missouri River fish? Is this habitat replacing natural sandbar habitat? **BIO**

52. What is the relationship between discharge and availability of sandbar habitat (i.e., area and elevation) in river reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams? What is the optimal range and timing of discharge for the creation, enhancement, and maintenance of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover? How much sandbar habitat is necessary to maintain recovery populations of terns and plovers? **H/H, BIO**

53. What is the relationship between discharge and the availability of shallow-water (i.e., side channels, chutes, oxbows, backwaters, sloughs) habitat in the riverine reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams in the spring and summer? What is the optimal range of timing of discharge to enhance and restore these habitats while maintaining flood control and other authorized purposes in each reach? How much and what depths of shallow-water habitat are needed to maintain healthy native fish populations? **H/H, BIO**

54. How do changes in main stem dam and reservoir operations affect the productivity of fish, wildlife, and invertebrate communities and their habitats (i.e., diversity, abundance, distribution)? What are the optimum flows, river stages, and reservoir elevations (or ranges of each) in the spring and the summer in each river reach or reservoir to optimize aquatic, riparian, and floodplain habitats and native fish and wildlife populations? **H/H, BIO**

58. How can operations (water and power) be managed to contribute to the value of habitat for large river dwelling aquatic resources generally considered as species in moderate to significant rates of decline? **H/H, BIO**

60. How can operations (water and power) be managed to contribute to the value of habitat for water associated resources such as cottonwoods, piping plover, least tern, various neotropical migratory bird species of birds, amphibians, reptiles? **H/H, BIO**

61. How should cold water (non-native salmonid) habitats be prioritized with respect to contributing to biological diversity? State and local economics? **BIO**

Hydraulics/Hydrology

1. How do river flows/reservoir operations affect surface area and depth of off-channel open water,(sloughs, chutes, backwaters) and wetland (palusterine emergent, forested, shrub/scrub habitats)? Alternatively, what flows by reach cumulatively optimize wetted area of off-channel habitat? **HAB**

4. What are bed elevation trends (aggradation/degradation) by river reach and how will habitats (types and acres) be affected? **HAB**

6. What velocity and flow regimes in the main channel, dike fields, and side channels of the Missouri River are preferred by various aquatic species? **BIO**

10. What effects do different river management scenarios have on the movement and placement of bottom sediments in various habitats within the Missouri River? **HAB**

11. What effect(s) does the timing (i.e hourly, daily, seasonally) and magnitude of releases from Garrison Dam (a.k.a. all dams) have on - a) habitat (e.g. backwater, side channels, sandbars, etc), b) fish reproduction, distribution and movements, and c) least tern, piping plover, and Canada geese nesting and rearing of young? **HAB, BIO**

13. Characterize habitat changes caused by river bed degradation and reservoir headwater aggradation and relate findings to long-term impacts on aquatic biota. **BIO**

20. Flood control activities/operations downstream of Ft. Randall and Gavins Point dams since 1952 frequently involves side channels, backwaters, chutes, and the main channel being dewatered (flows shut off and dramatically reduced) to the detriment of fish, macro invertebrates, and wildlife resources. How can populations of fish and wildlife resources in the unchannelized reaches below these two dams be protected rather than decimated during flood control activities? **BIO**

30. What is the present status of sedimentation, delta building, and habitat alteration along the Missouri River at the mouth of the Niobrara River? How far upriver and how far downriver of the Niobrara confluence is sedimentation, delta building, and habitat alteration occurring? What is the rate of sediment deposition at the mouth of the Niobrara River, as well as upstream and downstream? Provide future forecasts of sedimentation, delta building, and habitat alteration along the Missouri River as a result of Ft. Randall Dam releases. **HAB**

38. Does a riparian corridor, along the lower Missouri River, provide any significant protection for levees during flood events and reduce levee breaching?

39. Does a riparian corridor, along the lower Missouri River, cause a significant rise in flood stages?

44. What are the erosion/sedimentation parameters related to tributary inflows, reservoir shorelines and storage depletion?

46. What are the benefits associated with unbalanced management of reservoir storage?

55. What is the relationship of discharge, including daily peaking for hydropower, to bank erosion, river bed degradation, riverine and off-channel habitat availability (i.e., shallow-water habitats near sandbars, chutes, oxbows, backwaters, etc.), and accretion/delta formation in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams? What are the cumulative impacts of Federal and private bank stabilization projects in these riverine reaches on fish and wildlife habitat abundance and availability, population communities, and delta formation? What is the best way to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches? **HAB, BIO**

59. How can the impacts of habitat segmentation (dams) and hydrology alteration be distinguished from land use practices, point and non-point pollution (ag and M&I), fishing and over harvest, inter/intra specific competition, non-federal flow depletions? **WQ, BIO**

Water Quality

7. What causes and what are the ecological effects of low dissolved oxygen (as low as 2.5 mg/L) during rises of the Missouri River? **BIO**

9. What are the relationships between nutrients, turbidity and primary production and

between turbidity and the abundance of sight-feeding species? How would turbidity and nutrient availability change under different management scenarios? **BIO**

29. What is the status of water quality, water chemistry, and aquatic resources along the Missouri National Recreational River between Fort Randall Dam, South Dakota and Ponca State Park, Nebraska? Document the information that currently exists on these topics. Measure changes in water quality, water chemistry, and aquatic resources at various locations along the Missouri River periodically into the future. Relate the measurements on water quality and water chemistry to such uses as contact recreation, drinking water supply, and cold water fishery. **BIO**

40. What is the nutrient load of the lower Missouri River and how does it impact aquatic species? **BIO**

43. What are the trends in water quality parameters such as dissolved oxygen, temperature, total dissolved solids and some measure of trophic state? **BIO**

Policy

19. System operation of the Missouri River has not changed to reflect the fact that few barges move on the river and the total weight of commodities hauled are only a fraction of what the system was designed for. Essentially, water is being wasted at the expense of other uses that could be more profitable to each basin state and society in general. How could system water be more efficiently utilized to enhance fish and wildlife resources?

22. Present system modification and operation has narrowed the Missouri River and increased the velocity in the channelized section which negatively impacts user groups who would increase their recreational activities if it were more user friendly. How can the system be managed to support new economic growth in the recreational industry?

23. Operation of the present system has encouraged increased encroachment onto the floodplain and repeatedly rescued those who do so with public funds from the U.S. Treasury. As a consequence, Missouri River natural resources and the habitats needed to support them for future generations are diminishing at an accelerating rate. What can be done to manage floodplain encroachment in a manner both affordable to the taxpayer and compatible to the long term needs of fish, wildlife, and recreation?

62. How should operations identified to draw out positive biological responses be balanced to also meet such diverse non-biological demands as recreational reservoir levels (non-fishery), shoreline development (river and reservoir), river floating, concession operations?

Biota

3a. How do variations in river flow magnitude and timing affect **native fish recruitment**?
3b. How do variations in river flow magnitude and timing affect **benthic invertebrate production**?

8a. What effect do system operations have on the **quantity** of detritus in the Missouri River?
8b. What effect do system operations have on the **quality** of detritus in the Missouri River?

12a. Seasonally determine the magnitude of fish **transfer** from all dams.
12b. Seasonally determine the magnitude of fish **loss** from all dams.
12c. Seasonally determine the magnitude of fish **mortality** from all dams.

14a. Determine the importance of Missouri River tributaries for **fish reproduction**.
14b. Determine the importance of Missouri River tributaries for **general fish distribution**.

15. Develop reliable methodology for accurately determining the annual coldwater forage biomass in all reservoirs.

16. How much and to what extent has modification of the physical form of the Missouri River impacted the normal ecological functioning of this river? **Goal of Monitoring?**

17. Present system modification and operation has reduced water management flexibility for the Corps of Engineers. This in turn may be having an impact on fish carrying capacity (biomass of fish) in riverine sections (especially channelized reaches) because flow regimes are not synchronized with historic species reproductive cycles/time frames. What can be done to maximize the carrying capacity of fishery resources in the Missouri River? **Goal of Monitoring?**

18. A significant percentage of the water in the lower Missouri River (below Gavins Point Dam to the mouth) comes from tributary inflows. How can system releases be managed more efficiently for fish and wildlife purposes without seriously impacting other project users detrimentally? **Goal of Monitoring?**

24a. What tools are needed for predicting the response of **sport** fisheries to hydrologic manipulation?
24b. What tools are needed for predicting the response of **commercial** fisheries to

hydrologic manipulation?
24c. What tools are needed for predicting the response of **nuisance** fisheries to hydrologic manipulation?
24d. What tools are needed for predicting the response of **endangered** fishes to hydrologic manipulation?

27a. What is the impact of current system operation on **fish** which evolved under a hydrograph where there was a summer low flow?
27b. What is the impact of current system operation on **aquatic organisms** which evolved under a hydrograph where there was a summer low flow?
27c. What is the impact of current system operation on **riparian habitat** which evolved under a hydrograph where there was a summer low flow?
27d. What is the impact of current system operation on the **floodplain** which evolved under a hydrograph where there was a summer low flow?
27e. What is the impact of current system operation on **floodplain dependent organisms** which evolved under a hydrograph where there was a summer low flow?

34a. Status of **fisheries** affected by management of the system.
34b. Status of **riparian wildlife communities** affected by management of the system.
34c. Status of **migratory bird species** affected by management of the system.

35. What is the influence of non-native species on the native species of the system?

37. What are the critical limiting factors for the pallid sturgeon in the lower Missouri River?

42a. What is the status of **native** fish populations in reservoirs and free flowing river reaches between reservoirs?
42b. What is the status of **non-native** fish populations in reservoirs and free flowing river reaches between reservoirs?

48a. What effect does the current system of levees, constructed adjacent to the river, have on the river's **productivity**?
48b. What effect does the current system of levees, constructed adjacent to the river, have on the river's **biotic production**?

49a. What effect does the release of high water from Gavins Point Dam, during summer and fall months, have on the **survival** of fishes produced along the lower Missouri River?
49b. What effect does the release of high water from Gavins Point Dam, during summer and fall months, have on the **growth** of fishes produced along the lower Missouri River?

51. Has a delayed spring hydrograph altered the spawning sequence of large river fishes between Gavins Point Dam and the mouth of the Kansas River?

56a. What are the key or limiting factors to **native fish recruitment**?
56b. What are the key or limiting factors to **benthic invertebrate production**?

57. What is the probability that native Missouri River fishes, such as the paddlefish or endangered pallid sturgeon, would benefit from a fish passage structure at the main stem dams?

Habitat

2. How do river flows/reservoir operations affect channel morphology?

5a. What river training structure/bank stabilization designs or features best **diversify aquatic habitat** during normal summer navigation flows?
5b. What river training structure/bank stabilization designs or features **best increase shallow, low velocity water** during normal summer navigation flows?

21. What can be done to improve/increase shallow water habitats in order that species life requirements, including reproductive cycles, can be better met?

25a. What measures are good descriptors of the critical features of flow regimes and habitat diversity?
25b. What is the relationship among flow regime, habitat diversity and productivity? 25c. What habitat features are the most important and how much habitat of each kind is required?

26a. What are the abiotic end points that can be realistically targeted in rehabilitation programs?
26b. What does the mosaic of habitats that is critical to river form and function look like?

28a. What has been the effect of present day restoration efforts?
28b. What are the most effective/holistic techniques?
28c. What trends are - or should be - monitored to assess the impact of restoration efforts?

31a. What are the effects of dam releases on the cottonwood forest habitat along the Missouri River?
31b. Document whether and to what extent Missouri River farmland is being transformed into marshland.

32a. What management techniques can be used in the channelized section of the river to better approximate the natural system?
32b. What changes in the biotic community occur when these techniques are used?

33. What influence does water release patterns have on habitat availability in the lower river?

36. (What are the) Status and trends in quality and area of Missouri River habitats?

41. Are there areas of unique aquatic habitat in the lower Missouri River?

45a. What is the status of **riparian** habitat in and along the free flowing river reaches?
45b. What is the status of **aquatic habitat** in and along the free flowing river reaches?

47. What are the cumulative effects from rock control structure construction on system biota?

50a. How important is sand deposited by structures to year class strength of lower Missouri River fish?
50b. Is sand deposited by structures replacing natural sandbar habitat?

52a. What is the relationship between discharge and availability of sandbar habitat in river reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?
52b1. What is the optimal range and timing of discharge for the **creation** of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover?
52b2. What is the optimal range and timing of discharge for the **enhancement** of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover?
52b3. What is the optimal range and timing of discharge for the **maintenance** of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover?
52c. How much sandbar habitat is necessary to maintain recovery populations of terns and plovers?

53a. What is the relationship between discharge and the availability of shallow-water habitat in the riverine reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams in the spring and summer?
53b. What is the optimal range of timing of discharge to enhance and restore these habitats while maintaining flood control and other authorized purposes in each reach?
53c. How much and what depths of shallow-water habitat are needed to maintain healthy native fish populations?

54a1. How do changes in main stem dam and reservoir operations affect the productivity of **fish** communities and their habitats?
54a2. How do changes in main stem dam and reservoir operations affect the productivity of **wildlife** communities and their habitats?
54a3. How do changes in main stem dam and reservoir operations affect the productivity of **invertebrate** communities and their habitats?
54b1. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **aquatic** habitats?
54b2. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **riparian** habitats?
54b3. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **floodplain** habitats?
54b4. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **native fish** populations?
54b5. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **wildlife** populations?

58. How can water and power operations be managed to contribute to the value of habitat for species in moderate to significant rates of decline?

60a. How can water and power operations be managed to contribute to the value of **cottonwood** habitat?
60b. How can water and power operations be managed to contribute to the value of **piping plover** habitat?
60c. How can water and power operations be managed to contribute to the value of **least tern** habitat?
60d. How can water and power operations be managed to contribute to the value of **neotropical migratory bird** habitat?
60e. How can water and power operations be managed to contribute to the value of **amphibian** habitat?
60f. How can water and power operations be managed to contribute to the value of **reptile** habitat?

61a. How should salmonid habitats be prioritized with respect to contributing to **biological diversity**?

Hydraulics/Hydrology

1a. How do river flows/reservoir operations affect surface area and depth of off-channel open water and wetland habitats?
1b. What flows by reach cumulatively optimize wetted area of off-channel habitat?

4. What are bed elevation trends by river reach and how will habitats be affected?

6a. What velocity and flow regimes in the **main channel** of the Missouri River are preferred by various aquatic species?
6b. What velocity and flow regimes in the **dike fields** of the Missouri River are preferred by various aquatic species?
6c. What velocity and flow regimes in the **side channels** of the Missouri River are preferred by various aquatic species?

10a. What effects do different river management scenarios have on the **movement** of bottom sediments in various habitats within the Missouri River?
10b. What effects do different river management scenarios have on the **placement** of bottom sediments in various habitats within the Missouri River?

11a. What effect(s) does the timing and magnitude of releases from the dams have on **habitat**?
11b. What effect(s) does the timing and magnitude of releases from the dams have on fish **reproduction**?
11c. What effect(s) does the timing and magnitude of releases from the dams have on fish **distribution**?
11d. What effect(s) does the timing and magnitude of releases from the dams have on fish **movement**?
11e. What effect(s) does the timing and magnitude of releases from the dams have on **least tern** nesting and rearing of young?
11f. What effect(s) does the timing and magnitude of releases from the dams have on **piping plover** nesting and rearing of young?
11g. What effect(s) does the timing and magnitude of releases from the dams have on **Canada geese** nesting and rearing of young?

13a. Characterize habitat changes caused by **river bed degradation** and relate findings to long-term impacts on aquatic biota.
13b. Characterize habitat changes caused by **reservoir headwater aggradation** and relate findings to long-term impacts on aquatic biota.

20. Flood control activities/operations downstream of Ft. Randall and Gavins Point dams since 1952 frequently involves side channels, backwaters, chutes, and the main channel

being dewatered (flows shut off and dramatically reduced) to the detriment of fish, macro invertebrates, and wildlife resources. How can populations of fish and wildlife resources in the unchannelized reaches below these two dams be protected rather than decimated during flood control activities?

30a. What is the present status of sedimentation, delta building, and habitat alteration along the Missouri River at the mouth of the Niobrara River?
30b. How far upriver and how far downriver of the Niobrara confluence is sedimentation, delta building, and habitat alteration occurring?
30c. What is the rate of sediment deposition at the mouth of the Niobrara River, as well as upstream and downstream?
30d. Provide future forecasts of sedimentation, delta building, and habitat alteration along the Missouri River as a result of Ft. Randall Dam releases.

38. Does a riparian corridor, along the lower Missouri River, provide any significant protection for levees during flood events and reduce levee breaching?

39. Does a riparian corridor, along the lower Missouri River, cause a significant rise in flood stages?

44. What are the erosion/sedimentation parameters related to tributary inflows, reservoir shorelines and storage depletion?

46. What are the benefits associated with unbalanced management of reservoir storage?

55a1. What is the relationship of discharge, including daily peaking for hydropower, to **bank erosion** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?
55a2. What is the relationship of discharge, including daily peaking for hydropower, to **river bed degradation** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?
55a3. What is the relationship of discharge, including daily peaking for hydropower, to **riverine habitat availability** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?
55a4. What is the relationship of discharge, including daily peaking for hydropower, to **off-channel habitat availability** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?
55a5. What is the relationship of discharge, including daily peaking for hydropower, to **accretion/delta formation** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

55b1. What are the cumulative impacts of Federal and private bank stabilization projects in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams on **fish and wildlife habitat abundance and availability**?
55b2. What are the cumulative impacts of Federal and private bank stabilization projects in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams on **population communities**?
55b3. What are the cumulative impacts of Federal and private bank stabilization projects in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams on **delta formation**?
55c. What is the best way to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches?

59. How can the impacts of habitat segmentation (dams) and hydrology alteration be distinguished from land use practices, point and non-point pollution (ag and M&I), fishing and over harvest, inter/intra specific competition, non-federal flow depletions?

Water Quality

7a. What **causes** low dissolved oxygen (as low as 2.5 mg/L) during rises of the Missouri River?
7b. What **are the ecological effects** of low dissolved oxygen (as low as 2.5 mg/L) during rises of the Missouri River?

9a. What are the relationships between nutrients, turbidity and primary production?
9b. What is the relationship between turbidity and the abundance of sight-feeding species?
9c. How would turbidity and nutrient availability change under different management scenarios?

29a. What is the status of **water quality and water chemistry** along the Missouri National Recreational River between Fort Randall Dam, South Dakota and Ponca State Park, Nebraska? Document the information that currently exists on these topics. Measure changes in water quality and water chemistry at various locations along the Missouri River periodically into the future. Relate the measurements on water quality and water chemistry to such uses as contact recreation, drinking water supply, and cold water fishery.
29b. What is the status of **aquatic resources** along the Missouri National Recreational River between Fort Randall Dam, South Dakota and Ponca State Park, Nebraska? Document the information that currently exists. Measure changes in aquatic resources at various locations along the Missouri River periodically into the future.

40. What is the nutrient load of the lower Missouri River and how does it impact aquatic species?

43. What are the trends in water quality parameters such as dissolved oxygen, temperature, total dissolved solids and some measure of trophic state?

Policy

19. System operation of the Missouri River has not changed to reflect the fact that few barges move on the river and the total weight of commodities hauled are only a fraction of what the system was designed for. Essentially, water is being wasted at the expense of other uses that could be more profitable to each basin state and society in general. How could system water be more efficiently utilized to enhance fish and wildlife resources?

22. Present system modification and operation has narrowed the Missouri River and increased the velocity in the channelized section which negatively impacts user groups who would increase their recreational activities if it were more user friendly. How can the system be managed to support new economic growth in the recreational industry?

23. Operation of the present system has encouraged increased encroachment onto the floodplain and repeatedly rescued those who do so with public funds from the U.S. Treasury. As a consequence, Missouri River natural resources and the habitats needed to support them for future generations are diminishing at an accelerating rate. What can be done to manage floodplain encroachment in a manner both affordable to the taxpayer and compatible to the long term needs of fish, wildlife, and recreation?

61b. How should salmonid habitats be prioritized with respect to contributing to **state** and local economics?

62. How should operations identified to draw out positive biological responses be balanced to also meet such diverse non-biological demands as recreational reservoir levels (non-fishery), shoreline development (river and reservoir), river floating, concession operations?

Biota

Fish

3a. How do variations in river flow magnitude and timing affect **native fish recruitment**?

9b. What is the relationship between turbidity and the abundance of sight-feeding species?

11b. What effect(s) does the timing and magnitude of releases from the dams have on fish **reproduction**?

11c. What effect(s) does the timing and magnitude of releases from the dams have on fish **distribution**?

11d. What effect(s) does the timing and magnitude of releases from the dams have on fish **movement**?

12a. Seasonally determine the magnitude of fish **transfer** from all dams.

12b. Seasonally determine the magnitude of fish **loss** from all dams.

12c. Seasonally determine the magnitude of fish **mortality** from all dams.

14a. Determine the importance of Missouri River tributaries for **fish reproduction**.

14b. Determine the importance of Missouri River tributaries for **general fish distribution**.

15. Develop reliable methodology for accurately determining the annual coldwater forage biomass in all reservoirs.

20. Flood control activities/operations downstream of Ft. Randall and Gavins Point dams since 1952 frequently involves side channels, backwaters, chutes, and the main channel being dewatered (flows shut off and dramatically reduced) to the detriment of fish, macro invertebrates, and wildlife resources. How can populations of fish and wildlife resources in the unchannelized reaches below these two dams be protected rather than decimated during flood control activities?

24a. What tools are needed for predicting the response of **sport** fisheries to hydrologic manipulation?

24b. What tools are needed for predicting the response of **commercial** fisheries to hydrologic manipulation?

24c. What tools are needed for predicting the response of **nuisance** fisheries to hydrologic manipulation?

24d. What tools are needed for predicting the response of **endangered** fishes to hydrologic manipulation?

27a. What is the impact of current system operation on **fish** which evolved under a hydrograph where there was a summer low flow?

34a. Status of fisheries affected by management of the system.

37. What are the critical limiting factors for the pallid sturgeon in the lower Missouri River?

42a. What is the status of **native** fish populations in reservoirs and free flowing river reaches between reservoirs?

42b. What is the status of **non-native** fish populations in reservoirs and free flowing river reaches between reservoirs?

46. What are the benefits associated with unbalanced management of reservoir storage?

49a. What effect does the release of high water from Gavins Point Dam, during summer and fall months, have on the **survival** of fishes produced along the lower Missouri River?

49b. What effect does the release of high water from Gavins Point Dam, during summer and fall months, have on the **growth** of fishes produced along the lower Missouri River?

50a. How important is sand deposited by structures to year class strength of lower Missouri River fish?

50b. Is sand deposited by structures replacing natural sandbar habitat?

51. Has a delayed spring hydrograph altered the spawning sequence of large river fishes between Gavins Point Dam and the mouth of the Kansas River?

53c. How much and what depths of shallow-water habitat are needed to maintain healthy

native fish populations?

54a1. How do changes in main stem dam and reservoir operations affect the productivity of **fish** communities and their habitats?

54b4. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **native fish** populations?

56a. What are the key or limiting factors to **native fish recruitment**?

57. What is the probability that native Missouri River fishes, such as the paddlefish or endangered pallid sturgeon, would benefit from a fish passage structure at the main stem dams?

61a. How should salmonid habitats be prioritized with respect to contributing to **biological diversity**?

Birds

11e. What effect(s) does the timing and magnitude of releases from the dams have on **least tern** nesting and rearing of young?

11f. What effect(s) does the timing and magnitude of releases from the dams have on **piping plover** nesting and rearing of young?

11g. What effect(s) does the timing and magnitude of releases from the dams have on **Canada geese** nesting and rearing of young?

34c. Status of **migratory bird species** affected by management of the system.

52b1. What is the optimal range and timing of discharge for the **creation** of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover?

52b2. What is the optimal range and timing of discharge for the **enhancement** of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover?

52b3. What is the optimal range and timing of discharge for the **maintenance** of suitable sandbar habitat important to the conservation and recovery of the least tern and piping plover?

52c. How much sandbar habitat is necessary to maintain recovery populations of terns and plovers?

60b. How can water and power operations be managed to contribute to the value of **piping plover** habitat?

60c. How can water and power operations be managed to contribute to the value of **least tern** habitat?

60d. How can water and power operations be managed to contribute to the value of **neotropical migratory bird** habitat?

Wildlife - Other

27b. What is the impact of current system operation on **aquatic organisms** which evolved under a hydrograph where there was a summer low flow?

27e. What is the impact of current system operation on **floodplain dependent organisms** which evolved under a hydrograph where there was a summer low flow?

34b. Status of **riparian wildlife communities** affected by management of the system.

35. What is the influence of non-native species on the native species of the system?

54a2. How do changes in main stem dam and reservoir operations affect the productivity of **wildlife** communities and their habitats?

54b5. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **wildlife** populations?

55b1. What are the cumulative impacts of Federal and private bank stabilization projects in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams on **fish and wildlife habitat abundance and availability**?

55b2. What are the cumulative impacts of Federal and private bank stabilization projects in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams on **population communities**?

60e. How can water and power operations be managed to contribute to the value of **amphibian** habitat?

60f. How can water and power operations be managed to contribute to the value of **reptile** habitat?

Habitat

Aquatic

1a. How do river flows/reservoir operations affect surface area and depth of off-channel open water and wetland habitats?

1b. What flows by reach cumulatively optimize wetted area of off-channel habitat?

5a. What river training structure/bank stabilization designs or features best **diversify aquatic habitat** during normal summer navigation flows?

5b. What river training structure/bank stabilization designs or features **best increase shallow, low velocity water** during normal summer navigation flows?

6a. What velocity and flow regimes in the **main channel** of the Missouri River are preferred by various aquatic species?

6b. What velocity and flow regimes in the **dike fields** of the Missouri River are preferred by various aquatic species?

6c. What velocity and flow regimes in the **side channels** of the Missouri River are preferred by various aquatic species?

11a. What effect(s) does the timing and magnitude of releases from the dams have on **habitat**?

21. What can be done to improve/increase shallow water habitats in order that species life requirements, including reproductive cycles, can be better met?

25a. What measures are good descriptors of the critical features of flow regimes and habitat diversity?

25b. What is the relationship among flow regime, habitat diversity and productivity?

25c. What habitat features are the most important and how much habitat of each kind is required?

29b. What is the status of **aquatic resources** along the Missouri National Recreational River between Fort Randall Dam, South Dakota and Ponca State Park, Nebraska? Document the information that currently exists. Measure changes in aquatic resources at various locations along the Missouri River periodically into the future.

31b. Document whether and to what extent Missouri River farmland is being transformed into marshland.

33. What influence does water release patterns have on habitat availability in the lower river?

36. (What are the) Status and trends in quality and area of Missouri River habitats?

41. Are there areas of unique aquatic habitat in the lower Missouri River?

45b. What is the status of **aquatic habitat** in and along the free flowing river reaches?

47. What are the cumulative effects from rock control structure construction on system biota?

52a. What is the relationship between discharge and availability of sandbar habitat in river reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

53a. What is the relationship between discharge and the availability of shallow-water habitat in the riverine reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams in the spring and summer?

53b. What is the optimal range of timing of discharge to enhance and restore these habitats while maintaining flood control and other authorized purposes in each reach?

54b1. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **aquatic** habitats?

55a3. What is the relationship of discharge, including daily peaking for hydropower, to **riverine habitat availability** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

55a4. What is the relationship of discharge, including daily peaking for hydropower, to **off-channel habitat availability** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

58. How can water and power operations be managed to contribute to the value of habitat for species in moderate to significant rates of decline?

59. How can the impacts of habitat segmentation (dams) and hydrology alteration be distinguished from land use practices, point and non-point pollution (ag and M&I), fishing and over harvest, inter/intra specific competition, non-federal flow depletions?

Riparian

27c. What is the impact of current system operation on **riparian habitat** which evolved under a hydrograph where there was a summer low flow?

31a. What are the effects of dam releases on the cottonwood forest habitat along the Missouri River?

45a. What is the status of **riparian** habitat in and along the free flowing river reaches?

54b2. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **riparian** habitats?

60a. How can water and power operations be managed to contribute to the value of **cottonwood** habitat?

Restoration

26a. What are the abiotic end points that can be realistically targeted in rehabilitation programs?

26b. What does the mosaic of habitats that is critical to river form and function look like?

28a. What has been the effect of present day restoration efforts?

28b. What are the most effective/holistic restoration techniques?

28c. What trends are - or should be - monitored to assess the impact of restoration efforts?

32a. What management techniques can be used in the channelized section of the river to better approximate the natural system?

32b. What changes in the biotic community occur when these (restoration) techniques are used?

Other

27d. What is the impact of current system operation on the **floodplain** which evolved under a hydrograph where there was a summer low flow?

48b. What effect does the current system of levees, constructed adjacent to the river, have on the river's **biotic production**?

54b3. What are the optimum ranges of flows, river stages, and reservoir elevations in the spring and the summer in each river reach or reservoir to optimize **floodplain** habitats?

Hydraulics/Hydrology

2. How do river flows/reservoir operations affect channel morphology?

4. What are bed elevation trends by river reach and how will habitats be affected?

10a. What effects do different river management scenarios have on the **movement** of bottom sediments in various habitats within the Missouri River?

10b. What effects do different river management scenarios have on the **placement** of bottom sediments in various habitats within the Missouri River?

13a. Characterize habitat changes caused by **river bed degradation** and relate findings to long-term impacts on aquatic biota.

13b. Characterize habitat changes caused by **reservoir headwater aggradation** and relate findings to long-term impacts on aquatic biota.

30a. What is the present status of sedimentation, delta building, and habitat alteration along the Missouri River at the mouth of the Niobrara River?

30b. How far upriver and how far downriver of the Niobrara confluence is sedimentation, delta building, and habitat alteration occurring?

30c. What is the rate of sediment deposition at the mouth of the Niobrara River, as well as upstream and downstream?

30d. Provide future forecasts of sedimentation, delta building, and habitat alteration along the Missouri River as a result of Ft. Randall Dam releases.

44. What are the erosion/sedimentation parameters related to tributary inflows, reservoir shorelines and storage depletion?

55a1. What is the relationship of discharge, including daily peaking for hydropower, to **bank erosion** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

55a2. What is the relationship of discharge, including daily peaking for hydropower, to **river bed degradation** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

55a5. What is the relationship of discharge, including daily peaking for hydropower, to **accretion/delta formation** in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams?

55b3. What are the cumulative impacts of Federal and private bank stabilization projects in the reaches below Fort Peck, Garrison, Fort Randall, and Gavins Point Dams on **delta formation**?

55c. What is the best way to restore the dynamic equilibrium of sediment transport and associated turbidity in river reaches?

Water Quality

7a. What **causes** low dissolved oxygen (as low as 2.5 mg/L) during rises of the Missouri River?

7b. What **are the ecological effects** of low dissolved oxygen (as low as 2.5 mg/L) during rises of the Missouri River?

9a. What are the relationships between nutrients, turbidity and primary production?

9b. What is the relationship between turbidity and the abundance of sight-feeding species?

9c. How would turbidity and nutrient availability change under different management scenarios?

29a. What is the status of **water quality and water chemistry** along the Missouri National Recreational River between Fort Randall Dam, South Dakota and Ponca State Park, Nebraska? Document the information that currently exists on these topics. Measure changes in water quality and water chemistry at various locations along the Missouri River periodically into the future. Relate the measurements on water quality and water chemistry to such uses as contact recreation, drinking water supply, and cold water fishery.

40. What is the nutrient load of the lower Missouri River and how does it impact aquatic species?

43. What are the trends in water quality parameters such as dissolved oxygen, temperature, total dissolved solids and some measure of trophic state?

48a. What effect does the current system of levees, constructed adjacent to the river, have on the river's **productivity**?

Invertebrates

3b. How do variations in river flow magnitude and timing affect **benthic invertebrate production**?

8a. What effect do system operations have on the **quantity** of detritus in the Missouri River?

8b. What effect do system operations have on the **quality** of detritus in the Missouri River?

54a3. How do changes in main stem dam and reservoir operations affect the productivity of **invertebrate** communities and their habitats?

56b. What are the key or limiting factors to **benthic invertebrate production**?

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16. How much and to what extent has modification of the physical form of the Missouri River impacted the normal ecological functioning of this river? **Goal of Monitoring?**

17. Present system modification and operation has reduced water management flexibility for the Corps of Engineers. This in turn may be having an impact on fish carrying capacity (biomass of fish) in riverine sections (especially channelized reaches) because flow regimes are not synchronized with historic species reproductive cycles/time frames. What can be done to maximize the carrying capacity of fishery resources in the Missouri River? **Goal of Monitoring?**

18. A significant percentage of the water in the lower Missouri River (below Gavins Point Dam to the mouth) comes from tributary inflows. How can system releases be managed more efficiently for fish and wildlife purposes without seriously impacting other project users detrimentally? **Goal of Monitoring?**

38. Does a riparian corridor, along the lower Missouri River, provide any significant protection for levees during flood events and reduce levee breaching?

39. Does a riparian corridor, along the lower Missouri River, cause a significant rise in flood stages?